

News from the Technology Transfer Program

Novel methods for manufacturing photonic logic devices

raditional integrated electronic components have not kept pace with the performance demands of applications such as high-speed encryption, video on demand, and broadband television. Because optoelectronics (integrated photonics) promise to deliver greater speed and bandwidth than their electronic counterparts, some experts anticipate that they could one day make traditional electronic semiconductors obsolete. The widespread adoption of optical switching has increased pressure on industry to create fully photonic components to replace traditional electronic devices.

Even though research on photonic logic devices has been ongoing for several years, an integrated photonic device that could rival today's integrated electronic circuit does not yet exist. In particular, the ability to easily manufacture laser based devices and waveguides at the microcircuit level has presented challenges in the wafer fabrication stage. One specific issue has been the ability to develop optical interfaces, such as laser to waveguide, that do not have impedance mismatches.

NSA engineers within the Trusted Systems Research group in the Research Directorate took on the challenge. Their research resulted in methods to precisely manufacture photonics devices that use air gaps to tune the reflectance between optical devices (e.g., figure 1). These air gaps are formed by making a wafer mask with very precise regions that allow the deposition of sacrificial material onto the wafer forming spacers. This material is removed later by chemical etching processes. Engineers can now adjust the reflectance by varying the sacrificial spacer layers.

Another challenge facing photonic device developers is the specialized equipment required to manufacture sacrificial layers within a wafer. Working with the Laboratory for Physical Sciences (LPS), NSA engineers were able to develop methods of producing photonic devices using standard wafer manufacturing equipment such as Plasma Enhanced Chemical Vapor Deposition (PECVD) and later Biased Target Ion Beam Deposition (BTIBD). These novel methods opened up the potential for even more advanced devices since custom or highly specialized manufacturing equipment is not required. Another key to this technology is LPS's Projection Lithography Stepper tool (see figure 2) which projects the circuit image onto the wafer.

In late 2011, NSA's Technology Transfer Program (TTP) licensed 16 patented photonics manufacturing methods to industry. This technology transfer was one of the largest bundled patent deals in the history of TTP and reemphasized the commitment of NSA to return taxpayer-funded research and technology back to private industry.

FIGURE 1. An image of a fabricated mode transitiondiscrimination (MTD) photonic logic device with semiconductor laser edged facets and etched waveguide trenches.



